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Lake Cochrane Perimeter Road-Sediment Traps Project

(U.S.) Environmental Protection Agency, Denver, CO Region VIII

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16. ABSTRACT

Lake Cochrane is one of the few deep high quality prairie lakes in northeastern South Dakota. Local interests tried unsuccessfully for several years to develop measures to reduce sediment inflow. The proposal to develop sediment traps as a part of the lake's perimeter road system was selected for a grant award under EPA's "Clean Lakes" program initiated in 1975.

This small lake preservation project utilized the technical and/or financial resources of every level of government. For an allocated cost of about \$20,000, three sediment traps were developed to control the sediment inflow from 66% of the lake's watershed area. By incorporating the sediment traps into the perimeter road system, 2700 feet of new gravel road, the sediment traps, and a new boat access area were constructed at a cost of \$34,700. In addition, two of the sediment traps have been utilized as fish rearing ponds.

Due to limited data and numerous sediment-nutrient producing activities occurring concurrently, it has been difficult to evaluate the impact of the project on the lake. Preliminary evidence indicates good suspended solids removal in the sediment traps. There is evidence, however, that temporary storage of runoff water may not provide any nutrient removal. A comprehensive evaluation program needs to be developed.

The completed project has demonstrated a low cost, effective technique for reducing sediment inflow into a lake which may have application in other areas.

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Final Report

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LAKE COCHRANE PERIMETER ROAD-SEDIMENT TRAPS PROJECT
FINAL REPORT

by

Jerry L. Siegel
East Dakota Conservancy Sub-District
Brookings, South Dakota 57006

EPA CLEAN LAKES GRANT NO. S804248-01-2

Project Officer

Ronald M. Eddy

Environmental Protection Agency, Region VIII
Water Division
Denver, Colorado 80295

April, 1979

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This small lake preservation project utilized the technical and/or financial resources of every level of government. For an allocated cost of about \$20,000, three sediment traps were developed to control the sediment inflow from 66% of the lake's watershed area. By incorporating the sediment traps into the perimeter road system, 2700 feet of new gravel road, the sediment traps, and a new boat access area were constructed at a cost of \$34,700. In addition, two of the sediment traps have been utilized as fish rearing ponds.

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SECTION 1

INTRODUCTION

THE LAKE COCHRANE RESOURCE

Lake Cochrane is a very pretty 366-acre lake located close to the South Dakota-Minnesota border in Deuel County, South Dakota. The lake has intermittent surface water inflow, very infrequent surface outflow, and moderate groundwater recharge. Although the Prairie Coteau region in northeastern South Dakota has about 250 natural lakes, Lake Cochrane is one of a very few having a maximum depth greater than 200 feet.

The lake was ranked into the first priority grouping by the South Dakota State Lakes Preservation Committee (1977), meaning that it was ranked as one of the top ten lake resources of eastern South Dakota.

The lake is unique in this area in that it did not experience a noticeable algal bloom until the summer of 1971. Prior to this 1971 algal bloom, most local people felt that the lake would remain "crystal clear" forever.

Figure 1 is a map showing Lake Cochrane, its drainage area, and the surrounding area.

The total direct drainage area of the lake is very small at about 765 acres.

PROBLEMS AFFECTING THE LAKE

The major watershed problem affecting the lake before this project was developed was the sediment-nutrient inflow from three small drainage areas located on the southwest side of the lake. Heavy shoreline and lake bottom sediments found in that area provided strong evidence that these three watershed inflows were adversely affecting the lake.

The other main input of lake sediments and nutrients prior to 1976 was erosion and runoff resulting from sometimes careless construction of lakeshore residences. Although there are a number of lakeshore residences, seepage from domestic wastes has

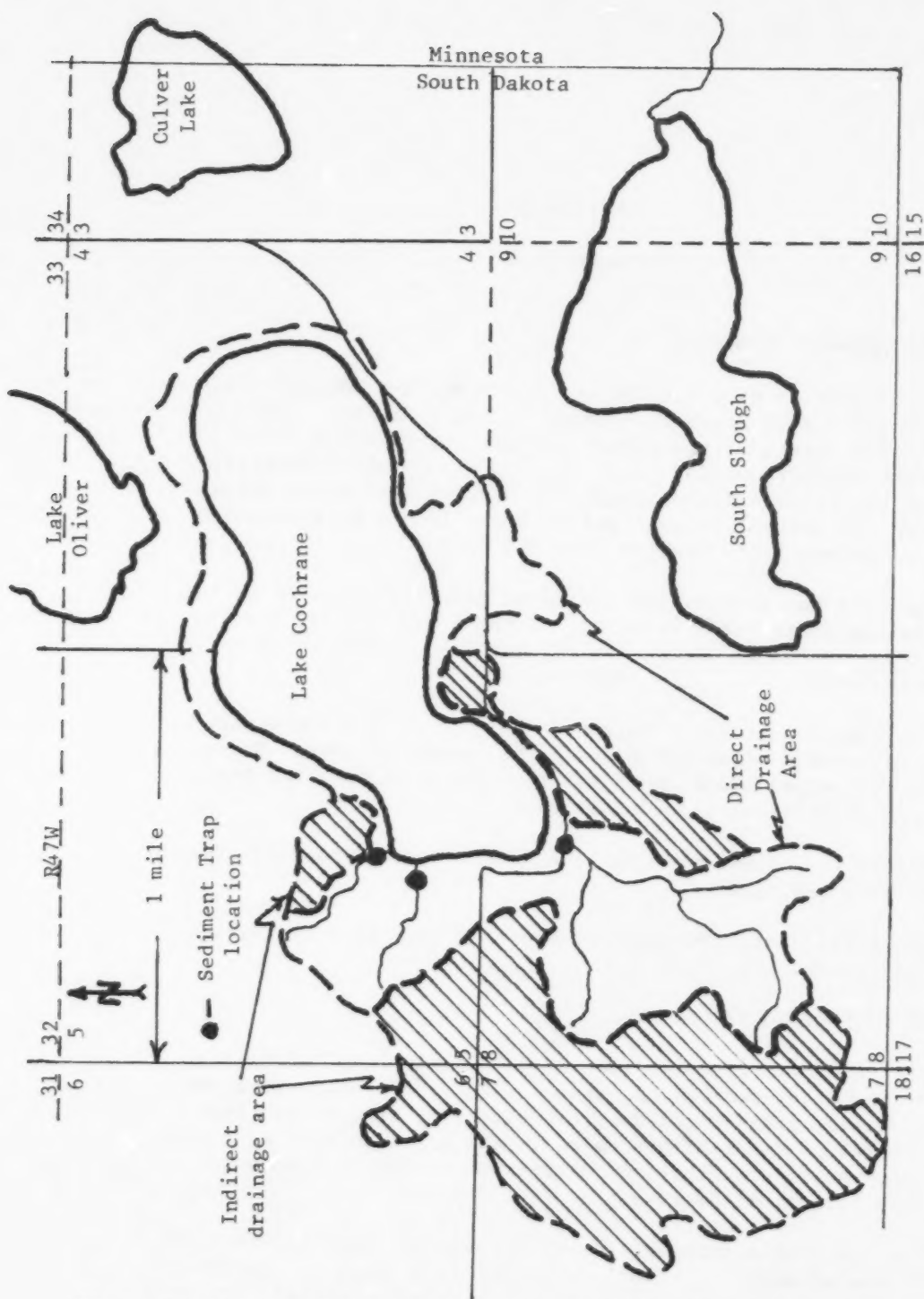


Figure 1. Map showing Lake Cochrane, the lake watershed, and surrounding area.

been minor due to a strong push to install sealed tanks as opposed to septic tanks and drainfields.

PUSH FOR ACTION TO PRESERVE THE LAKE

The urgency for reducing sediment and nutrient inflows received a strong boost from the 1971 algal bloom which was the first major evidence that this lake was becoming eutrophic. This interest received another boost in study reports prepared by Dr. Lois Haertel (1972), a biologist at South Dakota State University, and by Douglas Hansen (1973), a Watershed Biologist for the South Dakota Department of Game, Fish and Parks. Both reports strongly recommended development of sediment control measures for the lake.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

This project accomplished the stated project objective of demonstrating a low cost, effective technique for reducing sediment inflow into a lake by incorporating sediment traps into either existing or new roads located along the perimeter of the lake.

Nearly every high quality, heavily used lake has some type of access road developed around all or a portion of the perimeter of the lake. The landowners along this road system are generally willing to participate in efforts to preserve the lake because the quality of the lake directly affects their land values and their enjoyment of the lake.

Limited water quality data collected as a part of this project and research conducted by Dr. Haertel (1978) has provided evidence that temporary storage of runoff water will provide a significant reduction of suspended solids but may not provide any nutrient removal. This is a significant conclusion since a large portion of lake sediments in many prairie lakes is organic material produced within the lake itself. Thus, trapping inorganic sediments in watershed control structures while allowing nutrients which stimulate lake productivity to pass through will reduce but will not stop the filling of a lake with sediment and will not likely improve lake water quality.

The development of sediment control was cost effective under this multi-purpose technique because the road function financed a portion of the cost of the (a) earth fill, (b) structures to carry water through the roadway and (c) land rights.

This technique in many instances would have the following advantages:

- (a) Because land requirements for developing sediment control measures are reduced, land rights are also generally easier to secure.
- (b) The sediment control structures by being located on the perimeter road are located relatively close to the lake; thus sediments are restricted from adjacent

lands which often contribute a high percentage of the lake's sediment load.

- (c) By being located on a road, access for operation and maintenance purposes is much easier.

It is recommended that a comprehensive, well-planned monitoring program be developed which is geared to evaluating the efficiency of these sediment traps and their specific impact on the quality of Lake Cochrane.

The project facilities offer an opportunity to research the effectiveness of two different sediment trap designs. More importantly, the sediment traps with controlled drawdown tubes offer an important research facility for making a thorough evaluation of the impact of temporary versus more permanent water storage on nutrient removal efficiency. As noted above, the initial evaluation of this project has indicated that temporary water storage may not have a positive impact on lake water quality beyond restriction of inorganic sediments. There are many important questions in this regard that need to be answered before large amounts of public funds are used to develop sediment and/or nutrient control measures for shallow glacial lakes in the United States.

SECTION 3

DEVELOPMENT OF LAKE PRESERVATION PROJECT

DEVELOPMENT OF PROJECT CONCEPT AND GRANT PROPOSAL

In the early 1970's various local and state interests in eastern South Dakota began searching in earnest for methods and programs to accomplish the goal of developing sediment control measures for Lake Cochrane. They explored the possibility of reconstructing an existing township road crossing the lake's largest drainage course to make it function as a sediment trap. At the same time there was a strong interest in completing the perimeter road system around the lake's western side where the next two largest drainage inlets are located. Unsuccessful attempts were made to secure funds through the U.S. Department of Agriculture, South Dakota's Water Resources Institute and other programs.

The project did not fit any ongoing program in the early 1970's.

The U.S. Environmental Protection Agency, in releasing the first \$4 million of funds appropriated under Sections 104(h) and 314 of PL92-500 in 1976, stressed that high priority would be given to lake preservation and/or restoration proposals that

- (a) would demonstrate innovative new techniques,
- (b) would attack sources of lake problems such as sediment-nutrient inflows, and
- (c) could have wide application.

The East Dakota Conservancy Sub-District, working with other local interests, developed a project proposal to construct three low-cost sediment traps; the first by redesigning and reconstructing an existing township road and the other two by altering the design of a proposed new perimeter road where it would cross the two other main drainage inlets. The proposal was one of eleven projects in six states initially funded under the new federal "Clean Lakes" program.

TECHNICAL ASPECTS OF MULTI-PURPOSE PROJECT FEATURES

The multi-purpose project features were as follows:

- (a) Construction of 2700 feet of gravel road, this completing the lake's perimeter road system.
- (b) Development of three sediment traps, thus reducing the sediment inflow from 66% of the lake's total direct drainage area.
- (c) Development of a major new boat access area. This access area was developed as a multi-purpose use of a needed project borrow pit.
- (d) Multi-purpose use of two of the sediment traps as fish rearing ponds by the South Dakota Department of Game, Fish and Parks.

The two sediment traps incorporated into the construction of the new road (known as Sites 1 and 2), shown in Figure 2, were designed with manually controlled drawdown openings to allow permanent storage of water if desired up to the top of the riser pipes.

A schematic diagram of the sediment trap developed by reconstruction of the existing road (known as the Cochrane Site) is shown in Figure 3. Water cannot be permanently impounded because it has an uncontrolled drawdown tube.

Table 1 contains summary design information for all three sediment traps.

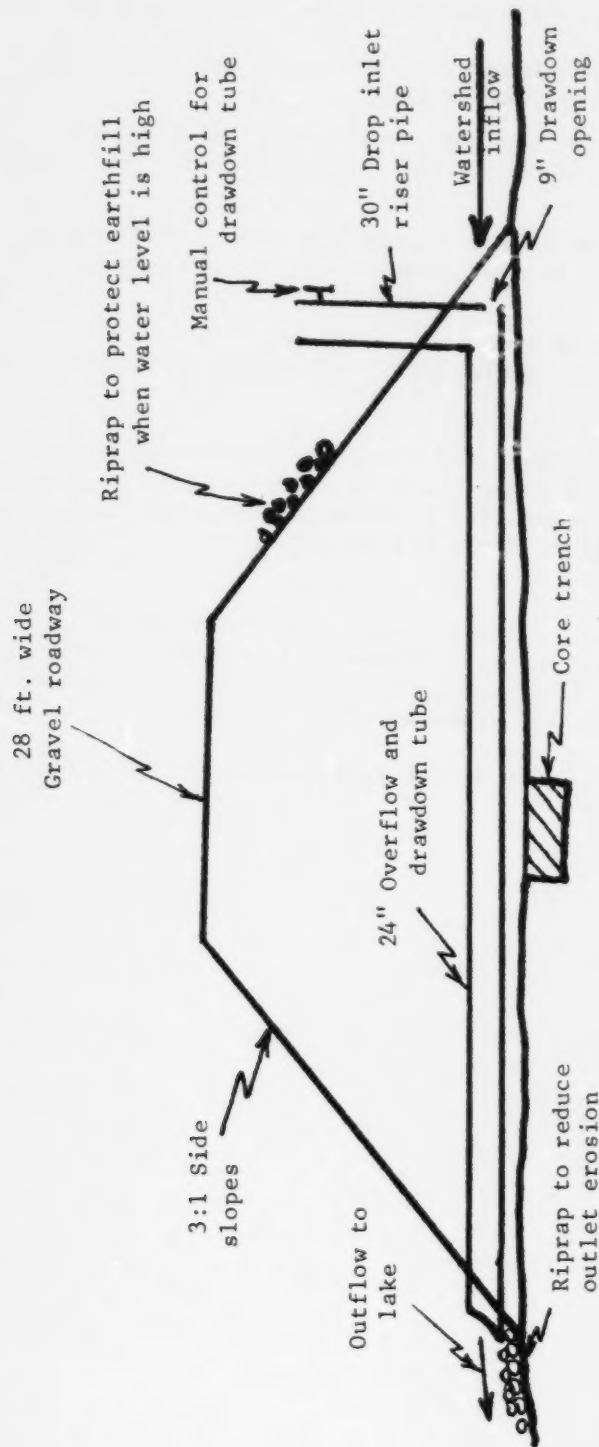


Figure 2. Schematic design of two sediment traps incorporated into construction of the new road.

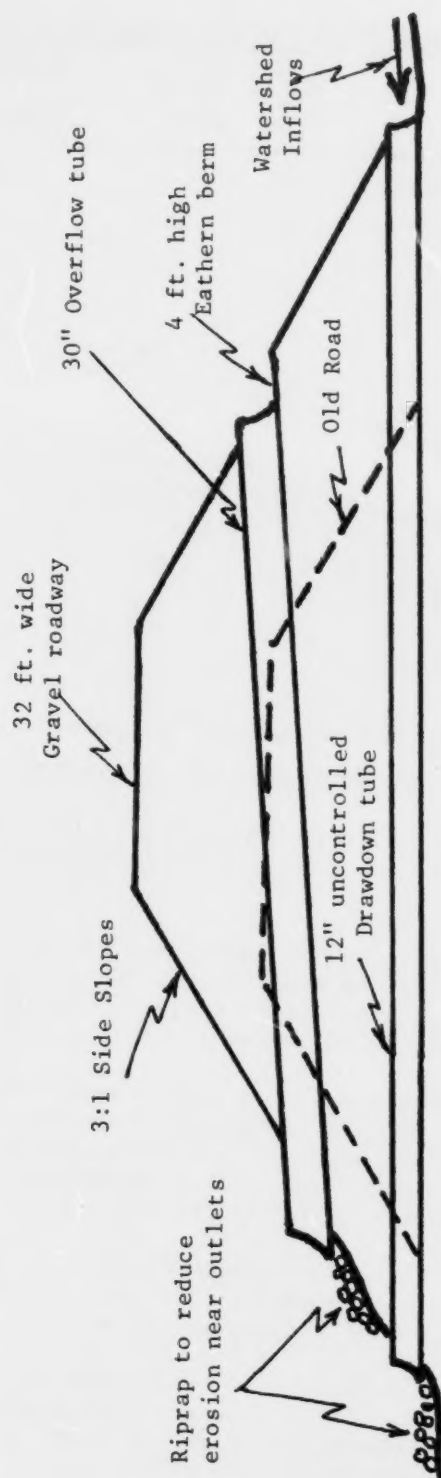


Figure 3. Schematic design of the existing road as redesigned to function as a sediment trap.

TABLE 1. DESIGN SUMMARY FOR ALL THREE SEDIMENT TRAPS

Design Feature	New Road		Existing Road
	North Site	South Site	Cochrane Site
Drainage Area (Acres)	41	57	411
Height of Fill (Feet)	15	19	7
Pool height at main overflow tube (Feet)	10	11	4
Storage at main overflow tube (Ac-ft)	5.0	3.4	11.6
Length - Main overflow tube (Feet)	108	128	84
Diameter - Main overflow tube (Inches)	24	24	30
Diameter - Riser pipe (Inches)	30	30	
Diameter - Drawdown tube or opening (Inches)	9	9	12
Controlled drawdown tube	Yes	Yes	No

MULTI-AGENCY PARTICIPATION IN PROJECT DEVELOPMENT

It is pertinent to review the participation of the six main governmental entities involved in the development of the overall project.

At the local level, Deuel County and Norden Township played a strong role by financing the construction of the new road and securing easements for the entire project. The county also handled the construction contracts for the project.

At a multi-county level, the East Dakota Conservancy Sub-District provided a \$10,000 grant toward the additional cost of incorporating the three sediment traps into the road system. The Sub-District also applied for and administered the EPA "Clean Lakes" grant and served as overall project coordinator

At the state level, the Department of Game, Fish and Parks contributed \$3,000 in cash and designed and supervised the construction of the new road portion of the project.

At the federal level, the Soil Conservation Service, assisting the local Deuel County Conservation District, designed and supervised the reconstruction of the Cochrane Site and EPA provided a \$9,906 grant toward the allocated cost of incorporating the three sediment traps into the road system.

Whenever a large number of entities are involved in the financing, design, construction and/or operation of a project, there is the strong likelihood that problems will develop. The five non-federal entities sought to avoid such problems by discussing in detail and arriving at clear-cut agreements on all aspects of project development. These agreements were incorporated into a five-party Memorandum of Agreement which all parties signed.

OBJECTIVES OF THE DEMONSTRATION PROJECT

According to the grant application, the objective of the project was to demonstrate a simple low-cost method of reducing lake sediment and nutrient inflow which should have wide applicability in the United States and to demonstrate the technique for both existing and planned new perimeter road systems.

PROJECT ACTIVITIES DURING GRANT PERIOD

It was noted in the original grant proposal that the Soil Conservation Service would design all project works. When all the non-federal entities met on August 21, 1976 and developed a Memorandum of Agreement for the project, it was decided to have the Department of Game, Fish and Parks design Sites 1 and 2 since the Department had offered to design and supervise construction of the road itself.

After the EPA grant was officially awarded on January 8, 1976 local entities took immediate steps to secure needed project easements and to ready the project for construction.

In early March the Project Manager notified Barbara Schroeder, who was placed in charge of the project by EPA officials in Denver, that Deuel County was ready to open bids for the project and asked for instructions. Construction bids were opened for the new road portion of the project on March 29, 1976 with six firms bidding. Halstead and Lewis Construction of Brookings, South Dakota submitted the low bid of \$21,089.47 which was accepted by the county commissioners.

Bids were opened by the commissioners for the Cochrane Site on April 20. The commissioners awarded the contract to Annet Construction, Inc. of Milbank, South Dakota who submitted a low bid of \$6,912.

On June 8, Bruce Perry, EPA-Denver, informed the Project Manager that John Brink was replacing Barbara Schroeder as Project Officer. On June 22, Mr. Brink toured the project and noted he was impressed with the construction work in progress.

The Game, Fish and Parks Department Engineer noted after a June 23 inspection of the new road portion of the project that

it was complete except for dressing the ditches, placing riprap and cleanup. He indicated that his department would seed the project area later in the fall.

On July 14, the Soil Conservation Service Area Engineer and Deuel County States Attorney notified the Project Manager that three problems had developed concerning the Cochrane Site: (1) a pipe specification change had resulted in an increased cost of about \$350; (2) access driveways to two lake lots had been omitted in the plans, and (3) the landowner on the south side "understood" that the county was going to do some private work for him if he gave a "free" easement for the project work. Meetings with the county, township and contractor were set by the Project Manager. Although the access driveways cost \$600 and the landowner was offered and paid a fair price for his easement, these problems were resolved without any additional EPA grant.

On July 29, John Brink, EPA Project Officer, called and asked the Project Manager to submit monthly reports. After reviewing the Project Grant Agreement, however, it was determined that the only monthly activity required was water quality monitoring. After a discussion of local laboratory limitations, Mr. Perry and Mr. Brink agreed during August to accept the bi-monthly monitoring program in progress.

By September, the construction work under both contracts was complete except for grass seeding. Mr. Brink toured the project area on September 20 and noted that with establishment of this grass cover the project would be satisfactorily completed.

On October 21, a dedication ceremony was held at the Shady Beach Resort on Lake Cochrane. The ceremony was well attended by local residents and received excellent area news coverage. Stuart McDonald and Barbara Schroeder represented EPA.

Sites I and II were seeded and mulched prior to the dedication. The Cochrane Site was not seeded at that time due to a standoff between Deuel County and the contractor regarding the seeding work.

During the spring runoff of 1977 all three sediment traps filled with water. Personnel were not able to get to the project area in time to collect water quality samples of the inflow and outflow of the sediment traps because the lake was located in a remote location, the runoff was unseasonably early, and the perimeter road was blocked with snow because it was not maintained during the winter season.

The Department of Game, Fish and Parks successfully reared walleyes that spring in Sites 1 and 2. They opened the drain tubes in late May to collect the fingerlings for distribution to Lake Cochrane and other lakes.

Bruce Perry, current EPA Project Director from Denver, toured the project on May 26. He was very favorably impressed with the project but urged the Project Manager to resolve the grass seeding stalemate at the Cochrane Site.

In October the Project Manager located a free source of native grass seed and asked the Game, Fish and Parks if they would seed and mulch the area for the \$200 contained in the construction contract for the seeding work. At a meeting between the county commissioners, Game, Fish and Parks and the Project Manager, on October 11, the seeding issue was resolved.

On October 18, the Project Manager set up a meeting between Jack Opitz, Department of Game, Fish and Parks (who was responsible for operating structure Sites 1 and 2) and Dr. Lois Haertel, SDSU Botany-Biology Department, to discuss her concern that the lake received a heavy nitrogen load when the sediment traps were emptied into the lake in early summer for fish removal. Mr. Opitz agreed to leave the drain tubes closed and remove the fish in another manner the following year to allow better nutrient removal.

On October 19, Mr. Opitz provided notification that he had inspected the project area and found that the 1976 seeding program was pretty well established.

On November 23, the Department of Game, Fish and Parks completed the seeding and mulching work on the Cochrane Site.

On November 30, final grant payment was requested from EPA for the completed work and Bruce Perry, EPA-Denver, was notified that the work was successfully completed.

In the spring of 1978 two sets of water samples of the sediment traps inflow-outflow were collected with considerable difficulty. The Project Manager determined that unauthorized personnel desiring a higher lake level had opened the drain tubes prior to the spring runoff. The tubes were closed in time to catch most of the runoff and were padlocked to prevent this from happening again. The inflow was heavy enough so that water flowed through the overflow tubes of all three sediment traps.

New EPA Project Officer, Debbie Patterson of Denver, inspected the project with the Project Manager on April 26. Sites 1 and 2 were still filled to the top of the risers (overflow tubes) whereas the uncontrolled Cochrane Site was completely drained down. Grass was well established on the project area.

The project was selected by EPA for presentation at the August 22-24 National Lakes Restoration Conference in Minneapolis. The Project Manager made the presentation.

Fish were not reared in Sites 1 and 2 during 1978. The north site (Site 1) held water all year whereas Site 2 eventually drained dry due to a leak in the drain tube. This leak was corrected in late 1978.

SECTION 4

RESULTS AND DISCUSSION

ECONOMIC FEASIBILITY OF THE TECHNIQUE

The cost of developing the sediment traps was reduced below the costs of normal development under this lake preservation technique because the road function financed a portion of the cost of

- (a) the earth fill,
- (b) structures to carry water through the roadway, and
- (c) needed land rights for the structures.

The full cost of reconstructing the existing road was allocated to the lake project since the road was already suitable for transportation purposes. The existing road fill and road easements reduced the costs of this construction, however.

Due to these multi-function cost savings, the cost allocated to the sediment traps was slightly less than \$20,000.

The \$20,000 allocated to the lake preservation project covered the following items not required in normal road construction:

- (a) Flood easements for the sediment pool areas;
- (b) Rip-rap of the face of these areas;
- (c) Increased fill height and width to provide desired water storage;
- (d) Excavation and refilling of a core trench, and
- (e) Increased costs resulting from design changes in the drainage structures; the added cost resulting from the need for caulked, close-riveted seams, water seepage collars and secondary overflow tubes is somewhat counter-balanced because when water can be stored behind the road fill, the diameter and thus the cost of the main drain tubes can be reduced.

TECHNICAL EFFECTIVENESS

Concurrent Impact of Other Activities

It is somewhat difficult at this point to draw definite conclusions on the impact of the completed sediment traps on lake water quality because very limited project data have been collected on the actual inflow-outflow of the sediment traps. It is very difficult to evaluate the sediment traps using in-lake data because of the concurrent impact on the lake of a number of sediment-nutrient producing construction activities. This construction has included a number of lakeshore homes, a new state park area on the north side of the lake, and the project works including the associated new road.

In addition, the lake area experienced a severe drought during 1974-77 which reduced normal surface and groundwater inflows and resulted in a lower than normal lake level.

Summary of Project Water Quality Data

There were no funds in the EPA grant to cover water quality monitoring. During the period of the grant, water quality samples were generally collected bi-monthly by the Project Manager under a cooperative East Dakota Conservancy Sub-District/Department of Environmental Protection lake monitoring program. Samples were analyzed by the State Health Laboratory in Pierre. It was difficult to meet grant requirements for chlorophyll a data since none of the main water quality laboratories in the state were equipped to analyze chlorophyll a.

The grantee did contract with Randall Brich, a Department of Biology graduate student at South Dakota State University, in July, 1977 for collect of chlorophyll a data which is shown in Table 2.

TABLE 2. LAKE CHOCHRANE CHLOROPHYLL a DATA

Station	Chlorophyll <u>a</u> mg/l - Average of 3 grab samples		
	8/16/77	9/4/77	9/22/77
1-S (southwest bay - surface)	12.1	11.2	11.4
3-S (northeast quadrant - surface)	13.1	10.4	13.2
3-B (northeast quadrant - bottom)	11.3	11.6	12.9

All water quality data collected under this grant agreement has been transmitted to the EPA regional office in Denver.

Table 3 contains average annual values for selected water quality parameters for the period 1975-1978.

TABLE 3. AVERAGE VALUES OF SELECTED WATER QUALITY PARAMETERS

		Unit	1975	1976	1977	1978
No. of Samples			3	5	4	4
Conductivity	micromho		3053/22	2782/23	3535/24	2700/23
Suspended Solids	mg/l		99	28	103	87
NH ₃ -N	mg/l		.125	.11	.34	.28
Ortho PO ₄ -P	mg/l		.022	.018	.011	.014
Total PO ₄ -P	mg/l		.034	.037	.036	.087

Table 4 contains values for selected constituents from samples collected and analyzed from the three sediment traps during the spring runoff of 1978.

TABLE 4. ANALYSIS OF SEDIMENT TRAP INFLOW/OUTFLOW

		ANALYSIS OF SEDIMENT TRAP INFLOW/OUTFLOW						
Parameter		Cochrane Site						
		(uncontrolled drawdown)						
		Inflow/Outflow		Inflow/Outflow		Inflow/Outflow		
		<u>March 29, 1978</u>						
Suspended Solids	mg/l	121	17	25	-	31	-	
NH ₃ -N	mg/l	.23	.48	.037	-	.07	-	
TKN-N	mg/l	1.65	1.21	1.67	-	.086	-	
Ortho PO ₄ -P	mg/l	.089	.150	.033	-	.082	-	
Total PO ₄ -P	mg/l	.168	.192	.111	-	.131	-	
		<u>April 4, 1978</u>						
Suspended Solids	mg/l	54	25	40	23	33	8	
NH ₃ -N	mg/l	.15	.19	.34	.19	.04	.07	
TKN-N	mg/l	.72	.80	1.71	.073	.82	.70	
Ortho PO ₄ -P	mg/l	.060	.108	.027	.018	.044	.053	
Total PO ₄ -P	mg/l	.075	.135	.075	.038	.062	.067	

These limited samples indicate good removal of suspended solids in the sediment traps.

Project Evaluation through other Research

Dr. Lois Haertel (1978) has evaluated lake water quality and algal abundance before, during and after construction of the sediment dams through a grant funded by the Office of Water Resources Research and Technology. Her data is much more complete than the project data noted above. The most recent project evaluation report is contained in the Appendix.

OPERATION OF THE SEDIMENT TRAPS

Effects of Design and Use for Fish Rearing

Multi-purpose use of two of the sediment traps as fish rearing ponds imposed two requirements in this case (a) the sediment traps had to be designed with manually controlled devices to close the drain tubes during spring and early summer and (b) efficient removal of the fingerlings required emptying the water in the sediment trap which allowed nutrient-laden runoff water to pass into the lake as noted below.

Use of the sediment traps for fish rearing might have either a desirable or undesirable impact on nutrient concentrations in the ponds. This aspect should be evaluated further.

Nutrient Removal Efficiency

For sediment control purposes only a structure is designed to reduce the velocity of water to the point that suspended solids will drop to the bottom of the pool area. This requires very little storage time except for the very fine sediment particles.

Theoretically a significant portion of the phosphorus load will be trapped along with these sediments because phosphorus is presumed to be attached to the soil particles. The limited sampling from the spring runoff of 1978, however, did not indicate good phosphorus removal. The phosphorus may be attached to the very fine particles which do not readily settle and stay at the bottom of the pond.

Nitrogen is dissolved in the runoff water and according to Dr. Haertel is probably equal in importance to phosphorus as a limiting factor in algal production in Lake Cochrane. A long detention period will be required for nitrogen removal in the sediment pools because the nitrogen will need to be taken up by plant growth.

REFERENCES

1. Haertel, L. 1972. Ecological factors influencing production of algae in northern prairie lakes. South Dakota Water Resources Institute, Brookings, South Dakota.
2. Haertel, Lois. 1978. Effect of sediment control dams on the water quality of Prairie Lake. Annual Report #A-061-SDAR submitted to OWRT.
3. Hansen, D. R. 1973. Watershed inventory of Lake Cochrane, Deuel County, South Dakota, 1971-1972. South Dakota Department of Game, Fish and Parks.
4. State Lakes Preservation Committee. 1977. A plan for the classification-preservation-restoration of lakes in north-eastern South Dakota. State of South Dakota and the Old West Regional Commission.

APPENDIX. INDEPENDENT PROJECT EVALUATION REPORT

Agreement No. 14-34-001-7088
Effect of Sediment-Control Dams
on the Water Quality of a Prairie Lake
OWRT Project No. A-061-SDAK
FCCSET (COWRR) Research Category: 6B

Proj. Began--Month: March Year: 1977
To be completed--Month: June Year: 1979

Principal Investigator: Lois Haertel

Student Assistant: Randall Brich

A. Research Project Accomplishments:

(1) Purpose of the Research Project

Three sediment control dams were constructed on Lake Cochrane South Dakota during the summer of 1976 with the purpose of decreasing the sediment and nutrient influx into the lake. Fortunately, 4 years of prior data had been collected from Lake Cochrane through other OWRT projects and a background data base was already present. The purpose of this project has been to evaluate the impact of the sediment control dams on water quality and algal growth both during and after construction of the dams.

(2) Lake Water Quality Response to the Sediment Control Structure

Sampling has been conducted approximately biweekly over 3 open water seasons both during the construction of the sediment control dam and the 2 seasons after its construction. Table 1 compares the results from 7 years of lake water quality data.

Table 1. Comparison of selected mean values from Lake Cochrane over 6 years of sampling

	1970	1971	1972	1975	1976 ^a	1977	1978 ^b
Water transparency (Secchi, m.)	2.0	1.3	1.3	1.6	1.2	1.1	1.2
Algae (chlorophyll <u>a</u> , ppb)	10	19	18	13	14	12	10
Zooplankton (calculated filtering rate, % water vol/day)	75	21	23	87	41	58	115
Chemical parameters (ppm)							
NO ₃ -N	.05	.03	.02	.02	.01	.03	.07
NH ₃ -N	.06	.02	.00	.04	.15	.44	.46
Organic N	1.12	1.55	1.35	1.27	1.38	1.48	1.18
Ortho PO ₄ -P	.01	.02	.01	.04	.02	.04	.01
Total PO ₄ -P				.16	.05	.22	.05
Acid-hydrolyzable PO ₄ -P	.03	.10	.02				

a) The sediment control structures were built in 1976.

b) Data computed through 7/26 (zooplankton), 8/16 (chemical data) and 8/31 (chlorophyll and Secchi disc readings).

Mean chlorophyll a and organic nitrogen values are definitely lower in 1978 than in any years after 1970. Whether this is a response to the lower phosphate levels in 1978, or the higher zooplankton estimated grazing rate is difficult to tell. Inorganic nitrogen levels remain high in 1978. Water transparency (secchi disc) levels are still poor in 1978; the low chlorophyll values suggest that this is partially due to non-algal turbidity. Although erosion from construction operations and from the steep slopes of the sediment control structures and boat landing areas is suspected as a cause of the low 1976 and 1977 transparency readings, better growth of vegetation on those slopes should have lessened that source of input in 1978. One cottage owner has completely laid bare a steep slope draining directly into the lake for private construction, and erosion off that slope may be contributing to the poor water transparency in 1978.

(3) Water Quality Measurements Above and Below the Sediment Control Dams

Due to an administrative oversight, the sediment dams were left open for much of the 1977 season. Thus, few measurements above and below the dams could be taken during that year. Two of the dams were kept closed during the 1978 season. Measurements were taken above and below the one dam that experienced seepage. The other dam was water tight and never had water going over the riser tube on any sampling date. Nutrients trapped behind that

dam were assumed to be effectively sealed off from the lake. Measurements taken above and below the second dam showed a surprising phenomenon. On 5/3/77, 4/20/78 and 5/16/78, water was going over the riser tube (Fig. 1) and flowing into the lake by the designed overflow method. On those dates, the measurements were higher above the dam than below (Table 2), as would be expected if settling or biological uptake behind the dam were reducing the quantities of nutrient going over the riser tube and through the culvert. However, on most subsequent dates, water was not going over the riser tube and seepage, possibly through a bad connecting joint at the base of the riser tube, had to be assumed to be the source of the water coming out. On almost all of those dates, nutrient concentrations were substantially increased rather than diminished below the sediment control dams. A possible source of the enrichment of the water with nutrients could have been percolation through the sediments behind the dam. The substantial increase in nutrient concentrations may not represent a threat to the water quality of Lake Cochrane, because the quantity of water draining out is small, and on most dates does not flow directly into the lake but on to a large flat vegetated beach area. The vegetation may be removing most of the nutrients before they get to the lake. However, the possibility of stopping the leakage should be investigated.

Year		1977		1978												1977		1978
Date	# reps	5/3	9/20	4/20	5/16	5/31	6/14	6/28	7/12	7/26	8/17	8/31	Mean	Mean				
Above-	Dam #			1	2	2	2	2	2	2	2	2						
Below:*				#2	#2	#2	#2	#2	#2	#2	#2	#2						
NO ₃ -N		.47	-.01	.20	.06	-.95	-.04	-.08	-.02	-.11	-.26	-.24	.23	-.16				
NH ₃ -N		.05	-.10	.10	-.05	-.32	-.15	-.60	-.70	.45	-.33	-.23	-.03	-.20				
Org.-N		0	-.05	-.18	-.12	.02	.28	-.31	.23	-.22	-.05	.77	-.03	.05				
Ortho-PO ₄		.02	.02	-.02	-.01	-.05	-.73	-1.22	-.12	.08	.18	.34	.02	-.17				
Total-PO ₄		.06	.09	-.02	.01	.04	-.97	-1.57	-.59	-.48	.10	.32	.08	-.36				
HCO ₃		0	-	120	-65	76	-109	-89	-85	-111	-144	-114	0	-58				
CO ₃		0	-	0	5	0	0	0	0	0	-5	-39	0	-4				
Si		-0.4	-	-	-2.1	7.5	-9.8	-8.8	6.7	-8.4	-22.0	-21.3	-.02	-15.3				

*A negative value means the concentration was higher below the sediment control dam than above it.